A Review on Voltage Sag Mitigation in Ultra Capacitor Based Dynamic Voltage Restorer (DVR)

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Abstract: *One product that can improve voltage sag and swell compensation with energy storage integration is the dynamic voltage restorer (DVR). Ultra capacitors (UCAP) have low energy density and high power density, making them suitable for compensating voltage sags and voltage swells, both of which demand high power for short periods of time. This work discusses the mitigation of voltage sag in ultracapacitor-based dynamic voltage restorers.*

Keywords: Voltage Sag Mitigation, Dynamic voltage restorer (DVR), Ultra capacitors (UCAP).

I. INTRODUCTION

The phrase "power quality" refers to the measurement of the quality of power delivered to customers' premises using indices such as voltage magnitude and frequency, waveform shape, and so on. Many factors, both within and outside the utility's control, cause these indexes to deviate from their nominal values. Voltage sags/swells, harmonics, long-term voltage disturbances, and other power quality issues are only a few examples. Power quality difficulties can arise from the switching of loads and capacitor banks, power system failures or short circuits, excessive machine starting currents, and a variety of other events. Voltage sag is the most essential power quality issue to address, according to a survey performed by the International Energy Agency. A voltage sag/swell is a brief drop or rise in voltage between 0.9 and 0.1 p.u. (sag) and 1.1 and 1.8 p.u. (swell) of the nominal rms value. Voltage sags or swells can last anywhere from half a cycle to one minute in most cases. For the alleviation of these power quality challenges, extensive study has been conducted in the literature. The research has mostly focused on the development of bespoke power devices. Hingorani created the phrase "power electronic devices" to describe a class of devices that can be used to improve the quality and dependability of electricity in a distribution network. Depending on the compensatory approach, these devices could be connected in series or shunt. One such series-connected custom power device that mitigates voltage sags and swells is the dynamic voltage restorer [1].

II. DYNAMIC VOLTAGE RESTORER (DVR)

A DVR (Dynamic Voltage Restorer) is a device that prevents voltage sags and swells. It consists of three single-phase injection transformers linked in series to the line and a voltage source inverter (VSI). The DVR system's control scheme detects variations in supply voltage magnitude and phase angle and injects a suitable voltage in series with the line, ensuring that the load does not experience any deviations from nominal circumstances. A simple block diagram of a common DVR system is shown in Figure 1. A voltage sag is defined as a drop in voltage levels in the range of 0.9 pu to 0.1 pu, often lasting half a cycle to one minute, as described in the previous section. A voltage swell, on the other hand, is defined as a voltage increase from 1.1 pu to 1.8 pu. Smaller sags/swells can be controlled solely by absorbing or supplying reactive power, however larger sags/swells may require active power assistance from the DVR system [2].

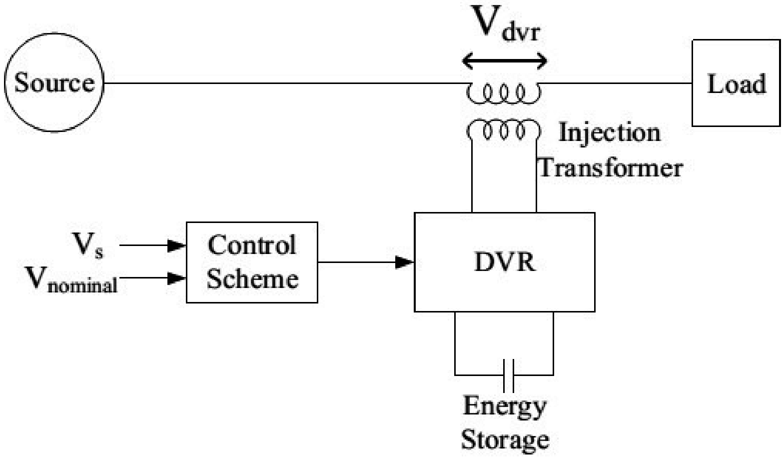

Figure 1: Block diagram of a typical DVR system.

III. LITERATURE SURVEY

For meeting the voltage restoration needs for industrial induction motor loads, Md. Riyasat Azim and Md. Ashraful Hoque [2] suggest a DVR with fast reaction, simple and efficient controller. The suggested DVR uses a Fuzzy Logic based feedback controller that uses the error signal (difference between the reference voltage and actual measured load voltage) to regulate the triggering of the switches of an inverter using a Sinusoidal Pulse Width Modulation (SPWM) scheme. The proposed DVR feeds the inverter with energy from accessible supply line feeders via a rectifier. The proposed model by Sachin V. Rajani et al. [3] correctly and precisely describes the UC properties. In comparison to methods that involve pulsed charging with exact current, voltage, and impedance measurements, as well as an analysis of the UC's frequency spectrum, the aforementioned method makes calculating comparable circuit characteristics more easier. The proposed method necessitates simple constant current charging and long-term voltage measurements. The average point approach is more accurate than the two point method when determining the immediate branch parameter values. After a series of tests on several UCs, the 350 F and 150 F ultra capacitors were chosen for further investigation. The ultra capacitors were put through their paces with a steady current of 5A.

For generating the gate pulses to the inverter, G Siva Rama Krishna and K Narasimha Rao [4] designed a voltage feedback PI-controller. In addition, the buck boost converter is controlled by an average current mode controller, which is a reliable controller for boosting and bucking DC voltage levels. In DVR, the voltage sags and swells are compensated using an in phase injection approach. An integration of rechargeable UCAP with DVR is presented by R. Bhavani and Dr. N. Rathina Prabha [5]. This UCAP-DVR features a modular, flexible system configuration with active power capability as well as deep, extended mitigation for power quality issues. The DVR is connected to UCAP via a bidirectional DC-DC converter, which provides a stable dc-link voltage for the DVR while simultaneously adjusting for temporary voltage sag and swell. UCAPDVR's performance is improved by using the FUZZY LOGIC Controller. The proposed system's simulation model was created in MATLAB, and the results were compared to those produced using traditional DVR.

The proposed system by Nikita Ambade and K. D. Joshi [6] consists of a super capacitor and the DVR's power circuit. As a result, DVR prevents any power interruption to that load. This paper shows how to use a Proportional Integral (PI) controller to control a super capacitor-based DVR. PSCAD/EMTDC software is used to simulate the system. This software's graphic capability aids in the execution of different areas of model implementation and simulation outcomes. Dr. M. Kalyanasundaram et al. [7] suggested a fuzzy-based complete DVR that performed well and was effective in three segments. A voltage supply inverter-based DVR with a fuzzy controller is modelled, and the same is installed in the distribution system to provide required load aspect repayment. If you want to teach the sample can find the sign of strong best trouble in real-time, you may use a BP-based manipulating algorithm to extract basic weighted prices of active and reactive power components of load currents. Pravin G. Bhende et al. [8] propose an enhanced DVR architecture that can be used to provide extended mitigation for PQ concerns. The suggested DVR uses an ultra-capacitor as an energy storage device since it produces a large amount of power in a short period of time, and it has been used as the active source for the DVR because of the various advantages it offers over a traditional battery. The current active power is managed by the integration of rechargeable energy storage, according to C. Subbaraju et al. [9.] Rechargeable Ultra Capacitors (UCAP) are to be combined for this type of application; this combination of UCAP & DVR system is the best suit for active power supply in the milliseconds to seconds range. Because ultra-capacitors can have both low and high energy densities, they can be used in a variety of applications. It has the ability to deal with both types of sags and swells. As proposed by S. Preetha et al. [10], UCAP is utilized as energy storage since it provides a large amount of electricity in a short period of time. The DVR is integrated into the Ultra-capacitor via a bidirectional DC-DC converter, which helps present a stable dc-link voltage while also adjusting for brief voltage fluctuations.

IV. CONCLUSION

Although a Dynamic Voltage Restorer (DVR) is one of the most effective solutions for power quality issues such as voltage sags and swells, individual DVRs lack the ability to control active power injection into the grid. To achieve such control and compensate for voltage sag, a trailing voltage in quadrature with the line current must be injected, i.e., rechargeable energy storage must be penetrated at the DVR's DC-terminal. This study presents an overview of current developments in voltage sag mitigation in ultra-capacitor based dynamic voltage restorers.

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